

**EVERY  
ALTERNATIVE.**

*The Compelling Case for  
Natural Gas Vehicles: A Fleet  
Seminar*

# Cummins Westport

## A Cummins JV Company

- CWI is a 50:50 joint venture company based in Vancouver, BC
  - Cummins Inc. - world's largest builder of commercial diesels,
  - Westport Innovations Inc. - world leader in gaseous fuel engine technology
- CWI offers 6 to 9 liter alternative fuel automotive engines. (CNG, LNG, LPG)
- Engines are manufactured by Cummins.
- Local parts and service support through Cummins Distributor network.

# Why Natural Gas Engines for Buses & Trucks?

## Emissions Leadership

- Meet 2010 EPA Emissions in 2007
- Lower greenhouse gas emissions



## Economic Benefits

- Improved Reliability
- Improved Efficiency
- Lower total fuel costs

## Energy Security

- Reduced reliance on imported oil
- Biomethane capable
- Pathway to hydrogen

# Market Drivers for Alternative Fuels

## 1. Emissions, concern for urban clean air:


- ✓ Non attainment areas / incentives / mandates
  - ✓ Federal/state/regional programs (1990 Clean Air Act)
  - ✓ Congestion mitigation & air quality (1991 CMAQ)
  - ✓ EPA Clean Fuel Fleet Vehicle program (1999 CFFV)
- ✓ 2002 EMA/CARB/EPA standard (2.5 g/bhp-hr NO<sub>x</sub> + HC)
- ✓ 2007 Highway and Energy Bill
- ✓ 2010 ?

## 2. Economics, total life cycle costs:

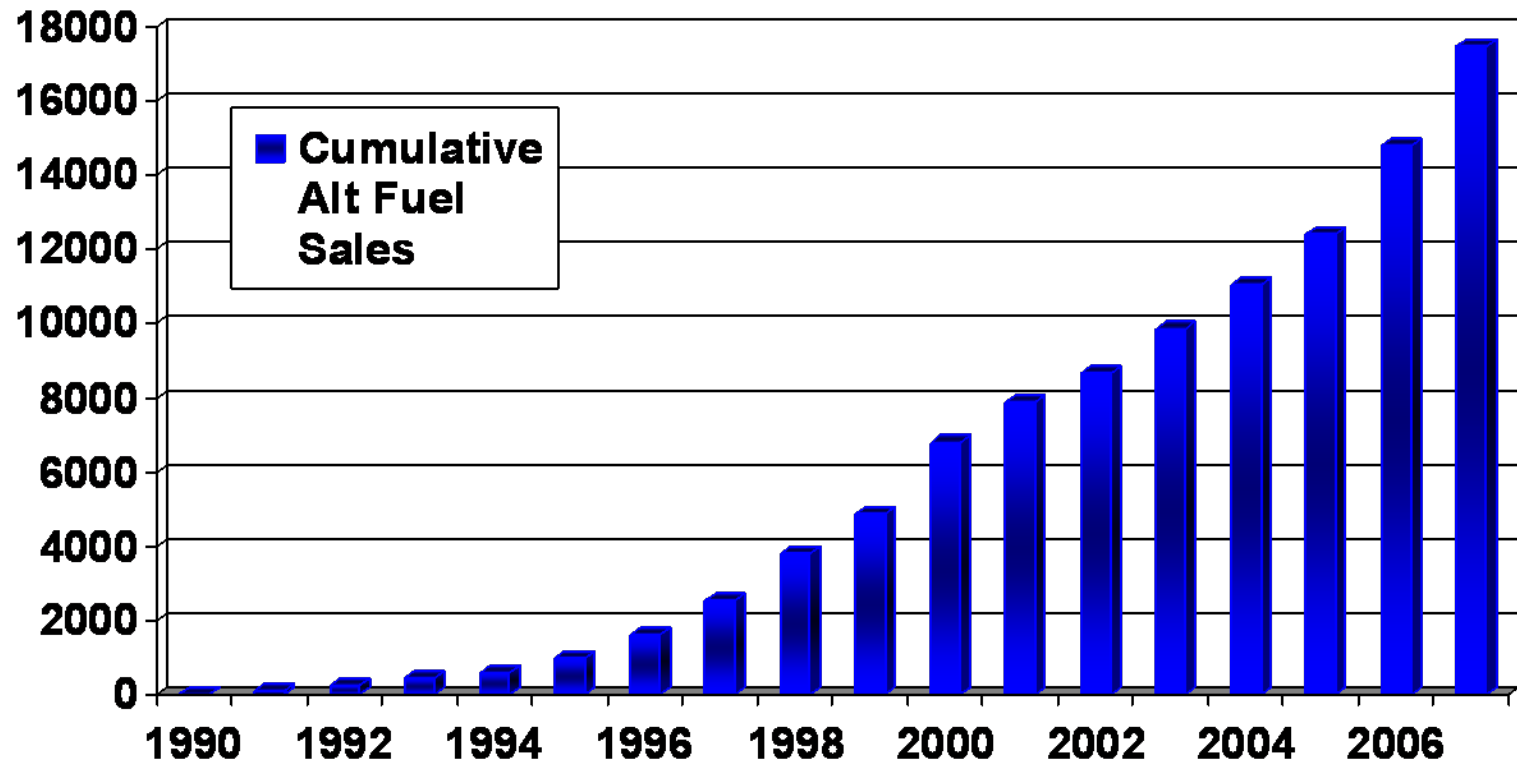
- ✓ Fuel price differential
- ✓ Incremental costs have declined

# Cummins Westport

## Heavy Duty Engines Designed Specifically for Alternative Fuels

- 
- A large, detailed image of a Cummins heavy-duty engine, shown in a light gray, semi-transparent style that allows the text to be read over it. The engine is a complex mechanical assembly with various components like the cylinder head, intake manifold, and oil pan visible.
- *Based on Reliable Cummins Engine Platforms*
  - *Common parts and design provide heavy duty performance*
  - *Engineered and Optimized Specifically for Alternative Fuel*
  - *Continued improvement in reliability and cost of ownership*
  - *Service Support through the Global Cummins Distributor network*

# Over 17,000 Engines Worldwide



# 2008 CWI Product Line

**B GAS**  
PLUS  
**B LPG**  
PLUS



**5.9 liter**

**Lean Burn**

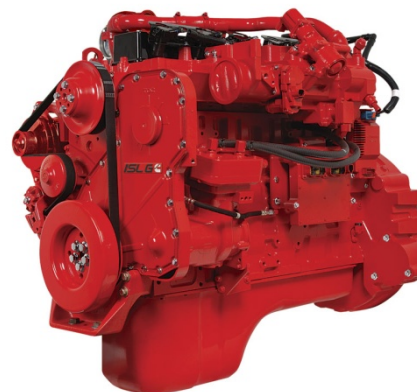
**195–230 hp**

**420–500 lb-ft**

**Certified 2007-9**

**Truck and Bus**

**ISL G**



**8.9 liter**

**Stoich EGR**

**250-320 hp**

**660-1000 lb-ft**

**Certified 2010**

**Truck and Bus**



**5.9L, LBSI, Full Electronics**

**Began production in 1994**

**Available thru 2009**

**Over 50 million miles  
operational experience**

## Applications

**Urban/Shuttle Bus**

**Medium Duty Truck**

**Specialty Vehicles**

## Engine Ratings

<u>Model</u>	<u>Horsepower</u>	<u>Peak Torque</u>
230	230 @ 2800	500 @ 2800
200	200 @ 2800	465 @ 2800
195	195 @ 2800	420 @ 2800





# B Gas Plus - Features

- 4 Cycle, 6 Cylinder, 2800 RPM Engine
- Lean burn, for fuel economy & emissions
- Installation more common to ISB (Retains 2VH)
- CM556 Engine Control
  - Latest Technology Controls
  - Increased speed, memory
  - Diagnostic capabilities of Insite and Quickcheck
  - Electronic throttle (drive-by-wire)
    - faster response and easier installation for bus/truck manufacturers
  - Capable of operating on lower quality natural gas
    - Methane number as low as 65
- Meets US EPA 07 Emissions
- Euro 3, Euro 5, EEV

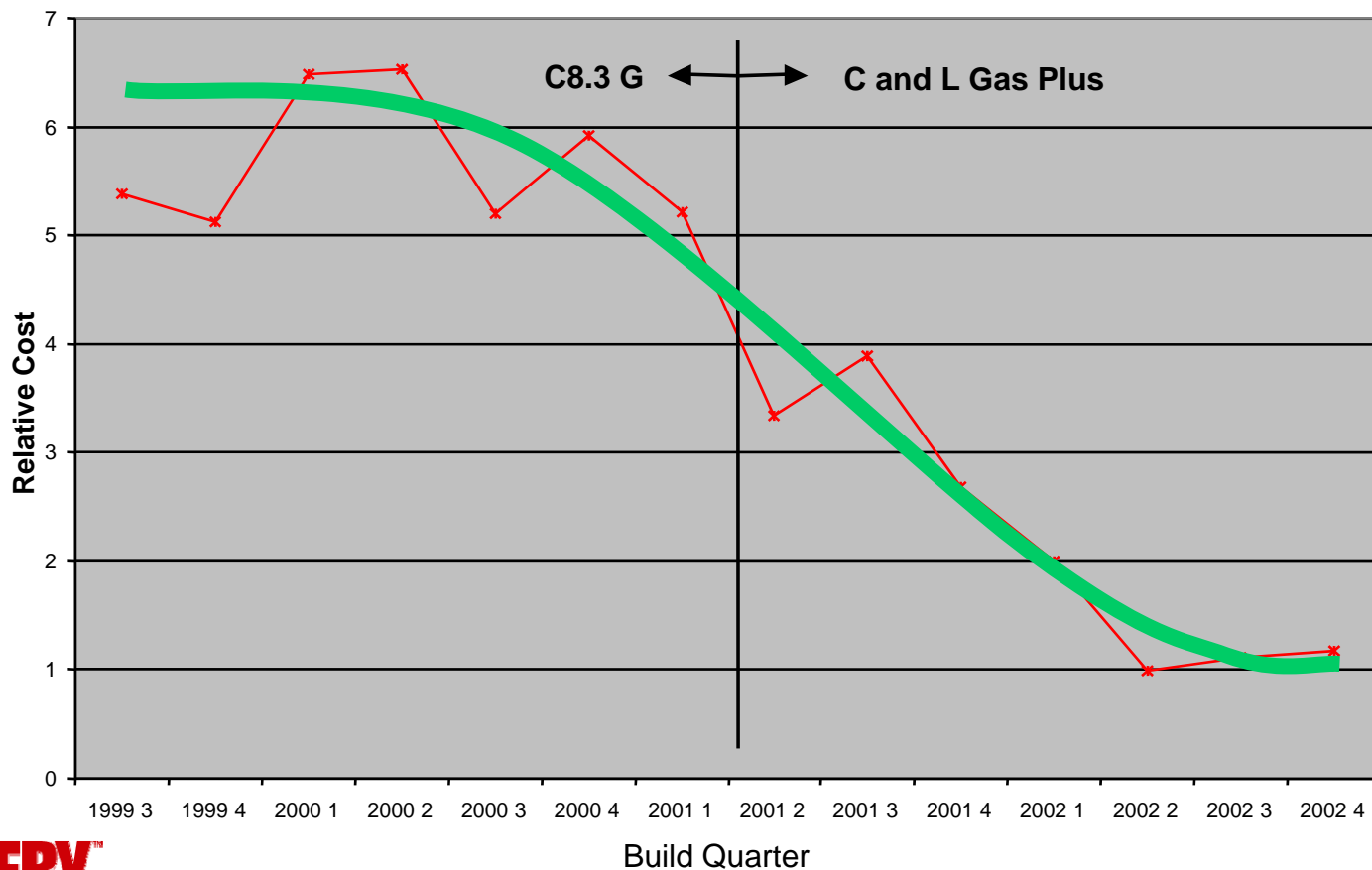
# Plus Technology

- The Plus control system technology enables several product enhancements
  - Advanced controls
    - Eliminate Woodward Governor
    - Customer features
    - Modern technology
  - Improved and new sensors including knock detection
    - Improved engine performance
    - Lower emissions capability
    - Wide range fuel capability
    - Engine protection
  - Improved troubleshooting & diagnostics (Insite 6.1)

# C Gas Plus

## Reliability Improvement

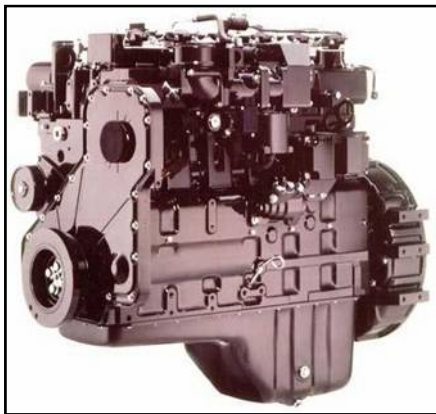
C8.3G / C and L Gas Plus - Reliability



Six Fold  
Reliability  
Improvement

# Four Generations of Natural Gas Engines

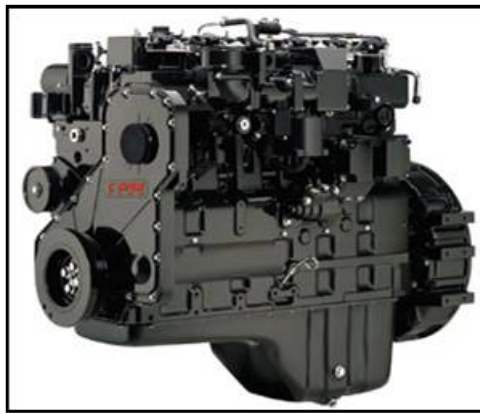
1998



## C8.3G Mechanical

- Introduced in 1998
- Major improvement over 1<sup>st</sup> generation CNG L10 Series
- Over 4000 still in service
- Improved Reliability

2001



## C Gas Plus

- Introduced in 2001
- State of the art spark ignition/control system
- First engine 2004 EPA Certified
- Six fold reliability Increase

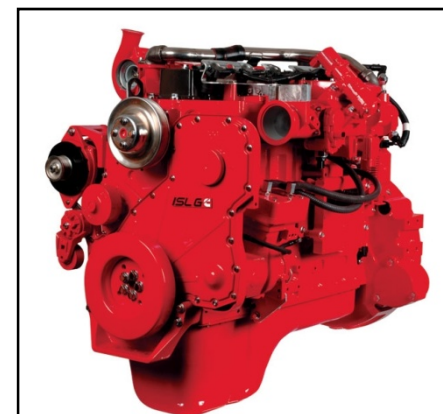
2004



## L Gas Plus

- Introduced in 2004
- Improved Ignition control system
- VG Turbo
- Based on 8.9 L ISL Block
- 2007 NOx and 2010 PM levels

2007

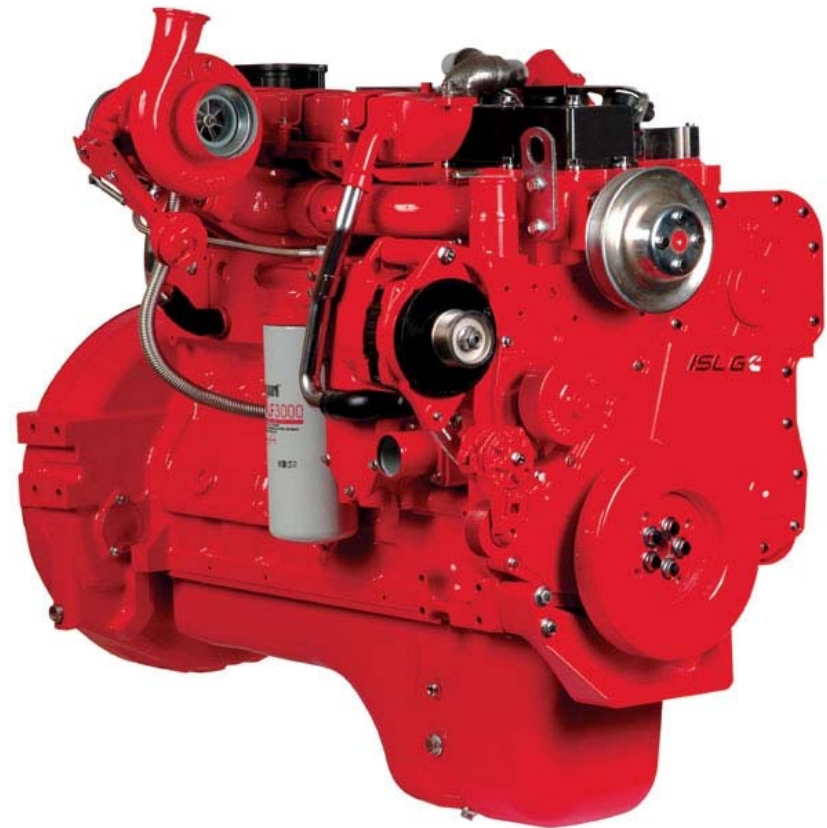


## ISL G

- Introduced in June 2007
- Stoichiometric EGR combustion
- Wastegate Turbo
- Three Way Catalyst
- First HD engine certified 2010 NOx and PM levels

# The New ISL G Natural Gas Engine

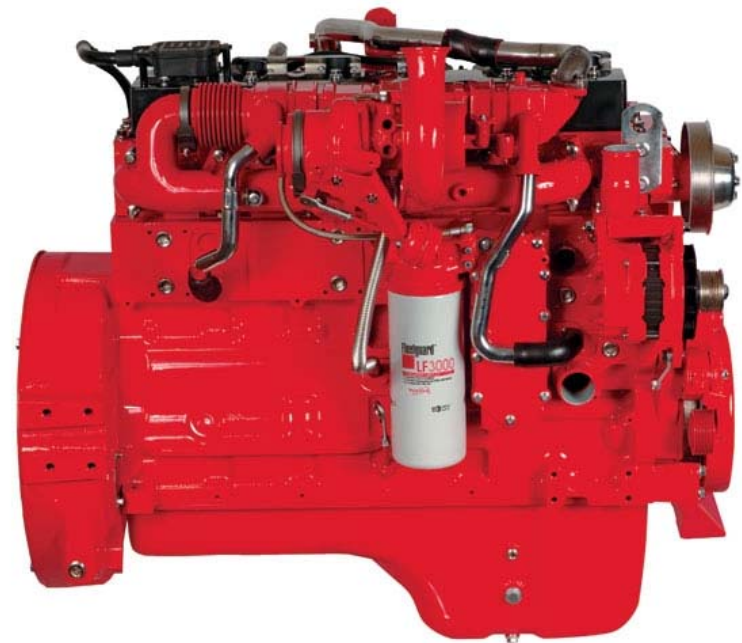
- 4 Cycle, Spark Ignited, In Line 6 Cylinder, Turbocharged, CAC natural gas engine
- Manufactured at Cummins Engine Plant - Rocky Mount, North Carolina
- ISL G replaces L Gas Plus and C Gas Plus engines in North America
- ISL G available in Europe and International Markets in 2008



**ISL G**

# 2007 ISL G – Key Benefits

- Shared block and components with 2007 ISL diesel
  - Over 80% parts commonality
- 85% lower NOx than C Gas Plus
- 5% efficiency Improvement Target
  - Lean Burn vs. Stoich EGR combustion.
- 34% more clutch engagement torque
  - Better performance
- Transit 280 hp rating torque improved to 900 lb-ft (+6%)
- Rated speed 2200 rpm
  - (same as diesel)



**ISL G**



# 2007 ISL G Features

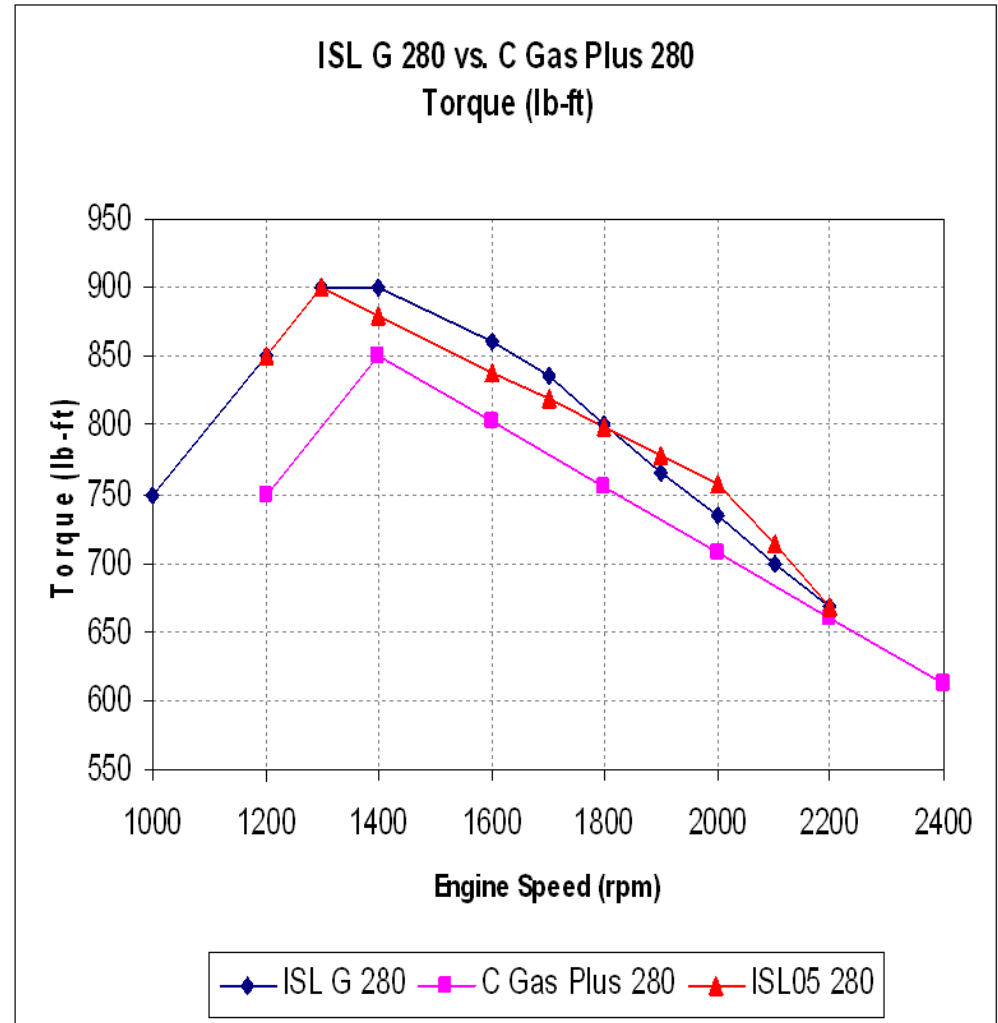
- **Stoichiometric EGR**
  - Stoichiometric Combustion is the ideal combustion process during which a fuel is burned completely.
  - SEGR uses high EGR rates in place of air and stoichiometric combustion to produce an oxygen free exhaust
- **Three Way Catalyst Aftertreatment**
  - Maintenance Free
  - simple passive device, highly effective hydrocarbon, CO, and NOx control.
- **New Electronic Control Module**
  - provides full monitoring and control of engine sensors, fuel system and ignition system
- **Cummins Cooled EGR**
  - Same EGR valve and manifold as Cummins Diesel
  - lowers in cylinder temperature and reduces oxygen concentration
- **Improved torque throughout operating range**
- **Improved efficiency**

# 2007 ISL G Ratings

ENGINE MODEL	ADVERTISED HP(KW) @ RPM	PEAK TORQUE LB-FT @ RPM	GOVERNED SPEED
ISL G 320	320 (239) @ 2000	1000 (1356) @ 1300	2200 RPM
ISL G 300	300 (224) @ 2100	860 (1166) @ 1300	2200 RPM
ISL G 280	280 (209) @ 2000	900 (1220) @ 1300	2200 RPM
ISL G 260	260 (194) @ 2200	660 (895) @ 1300	2200 RPM
ISL G 250	250 (186) @ 2200	730 (990) @ 1300	2200 RPM

# ISL G – Next Generation Natural Gas Engine

- Stoichiometric Engine
- Lowest emissions
  - **0.20 g/bhp-hr NOx**
  - **0.01 g/bhp-hr PM**
- Higher efficiency
  - Target: 5% fuel economy improvement vs. CWI's current products
- Diesel-like reliability & durability
- Improved performance – 34% Higher clutch engagement torque



# ISL G - Conclusions

- Meets 2010 Emission Standards, today.
- No exhaust system related maintenance costs.
- More fuel efficient than previous engines.
- Improved clutch engagement torque (+34%)
- 80% of design based upon diesel engine platform
- Parts and service support from the Cummins Distributor Network
- Uses a renewable fuel found in North America
- Substantial GHG Reductions

# Fuel Pricing Creates Economic Advantage

Fuel price differential creates overwhelming benefit for NG

Breakeven:

\$0.73/DGE

\$0.93/DGE

\$0.62/DGE



**\$0.10 Saved in Fuel Translates into vehicle savings per year:**

Transit

\$1,500

200 buses  
\$7.2 M Capital  
45,000 miles-3.5 mpg

Refuse

\$1,200

50 Trucks  
\$875K Capital  
15,000 miles-1.5 mpg

Truck

\$1,200

50 Trucks  
\$875K Capital  
65,000 miles-6.5 mpg

# ISL G Applications

TRUCK



SPECIALTY



BUS



REFUSE



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- Trucks
  - AutoCar, Condor, Crane Carrier, and Peterbuilt
    - All are currently offering ISLG
  - Freightliner Custom Chassis – MT45/55, MB55
  - Freightliner LLC (Sterling Trucks - L Series - 2008)
  - Freightliner M2 (Q1-2009)
- Buses
  - Transit
    - NABI, New Flyer, and Orion. (Current and new product)
  - Shuttle
    - El Dorado and Trolley Enterprises (Current and new product)
  - School
    - Blue Bird and Thomas.

# Maintenance Schedule

## ISL G Maintenance Schedule<sup>(1)</sup>

Daily or Refueling	Every 12,000 km (7,500 Mi), 500 Hrs or 6 Months <sup>(1)(3)</sup> Whichever Comes First	Every 24,000 km (15,000 Mi), 1000 Hrs or 12 Months <sup>(1)(3)</sup> Whichever Comes First	Every 36,000 km (22,500 Mi), 1500 Hrs or 18 Months <sup>(1)(3)</sup> Whichever Comes First	Every 48,000 km (30,000 Mi), 2000 Hrs or 2 Years <sup>(1)(3)</sup> Whichever Comes First
Operator's Report - Check	Catalyst Housing - Check Exterior	Drive Belt - Check	Spark Plugs and Boots- Replace <sup>(6)</sup>	Vibration Damper - Check
Engine Oil - Check, add if required	Air Cleaner - Check	Automatic Belt Tensioner - Check	Ignition Coils - Check	Turbocharger - Check
Engine Coolant - Check, add if required	Charge Air Cooler - Check	Fan Hub, Belt Driven - Check		Engine Coolant - Flush and Replace
Cooling Fan - Check	Charge Air Piping - Check	Water Pump - Check		Air Compressor - Check
Radiator Hose - Check	Lubricating Oil - Change <sup>(4)</sup>	Catalyst - Check		
Air Intake Piping - Check	Lubricating Oil Filter - Change <sup>(4)</sup>	Engine Fuel Filter - Replace		
Fuel Filter - Drain <sup>(2)</sup>	Supplemental Coolant Additives (SCA) and Antifreeze - Check <sup>(5)</sup>	Overhead Valve Lash- Adjust <sup>(7)</sup>		
Throttle Response - Check	Coolant Filter - Change <sup>(5)</sup>			
Crankcase Breather Tube - Check				

**Note:** Refer to the appropriate manual for complete inspection and maintenance procedures.

- Follow the manufacturer's recommended maintenance procedures for the starter, alternator, generator, batteries, electrical components, air compressor, refrigerant compressor, fan clutch, and OEM fuel filter.
- Interval period for draining the fuel filter is dependent on the fueling station and varies for each location. The drain interval should be adjusted to the time required to accumulate no more than one ounce of oil in the fuel filter.
- At each scheduled maintenance interval, perform all previous checks in addition to the ones specified.
- Refer to Table 1, Oil Drain Intervals for oil and filter change intervals based on average speed.
- Do **not** change the coolant filter if the SCA is over 3 units. Refer to Section V.
- Use only Cummins authorized spark plugs for scheduled maintenance or repairs. The use of unauthorized parts can affect performance and emission control system. The recommended 36,000 km [22,500 mile] interval is based on an average vehicle speed of 24 kph [15 mph] and must be derated accordingly for slower speed applications (i.e. 1500 hr times average kph [mph] = distance maintenance interval).
- Initial valve lash adjustment only - thereafter regular adjustment interval is 2000 hours

# Warranty-Every Coverage

## Bus/Shuttle/Coach

- Standard 2 years Unlimited Mileage/Kilometers with full parts and labor coverage on warrantable failures.
- Major components are covered for 3 years / 300,000 miles (482,804 km.)

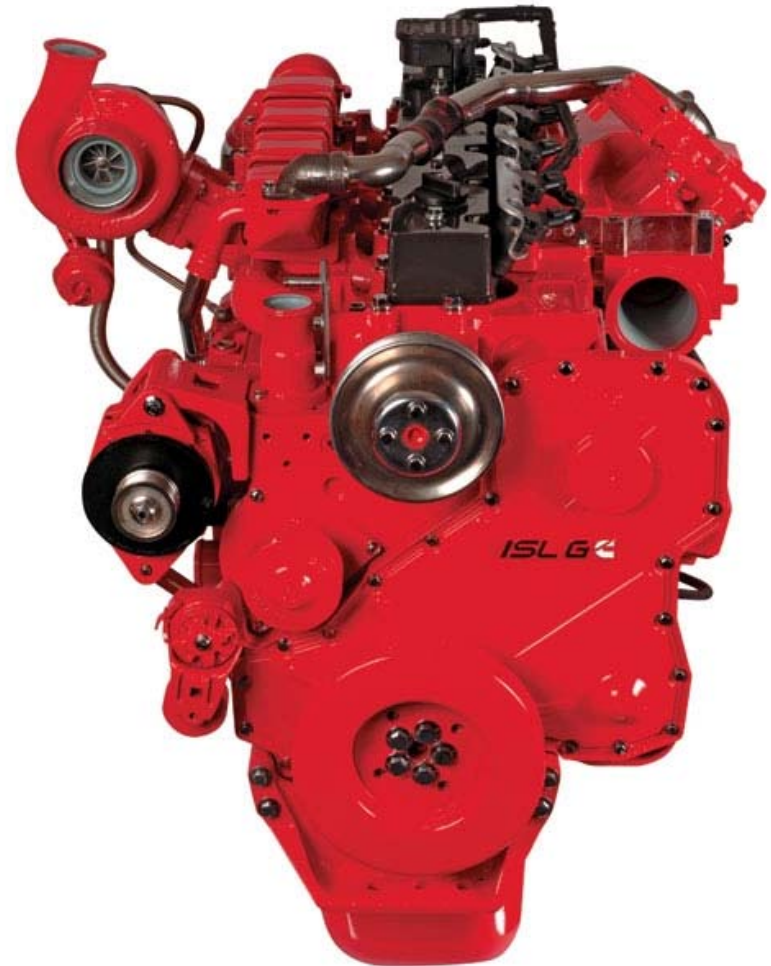
## Truck

- Full engine coverage is provided for 2 years / 250,000 miles (402,336 km) whichever comes first

- *Base coverage is same as diesel, extended coverage available!*
- *All warranty programs administered per Cummins Standard Policies*

# More information?

- For more information:  
Bill Boyce  
East Regional Manager  
(330) 720-9785
- Or visit  
[www.cumminswestport.com](http://www.cumminswestport.com)



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**Cummins Westport Inc.**

A scenic landscape photograph showing a range of snow-capped mountains under a blue sky with wispy clouds. The foreground consists of rolling green hills.